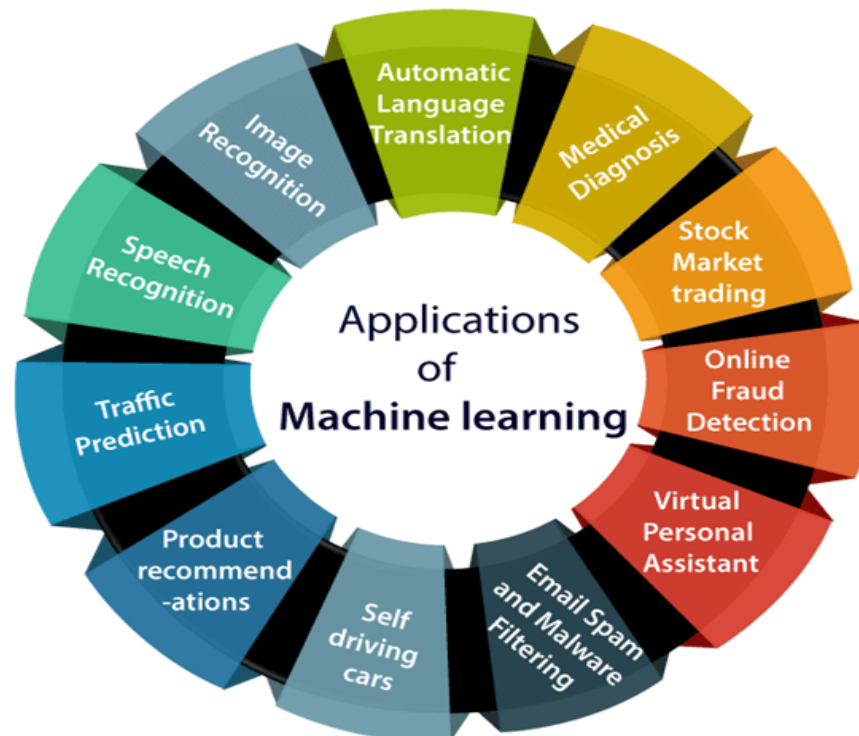


Chapter 3: Introduction to Machine Learning

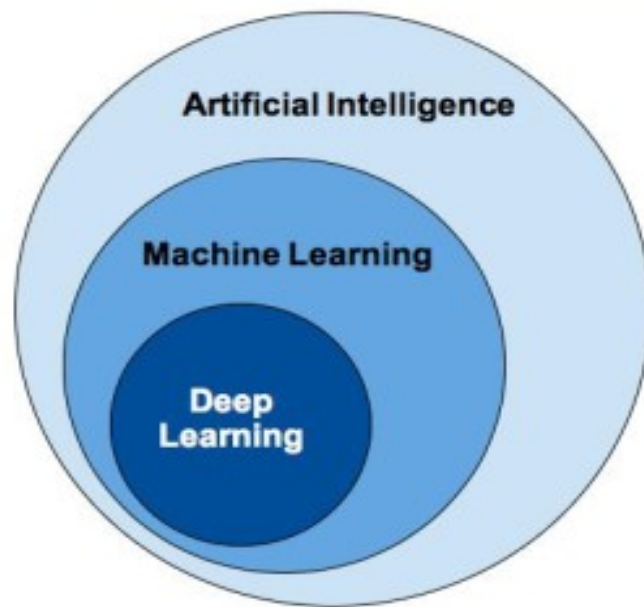
Brain Storm ?

- When you **tag a face in a Facebook** photo, it is AI that is running behind the scenes and identifying faces in a picture
- We have **autonomous cars running** on our roads that detect objects in real time to steer the car
- When you travel, you **use Google Directions to learn the real-time traffic situations** and follow the best path suggested by Google at that point of time
- **Google Translator application** that we typically used for language translation
- Speech to text and Vice versa applications Siri on iphone

Application Areas of ML

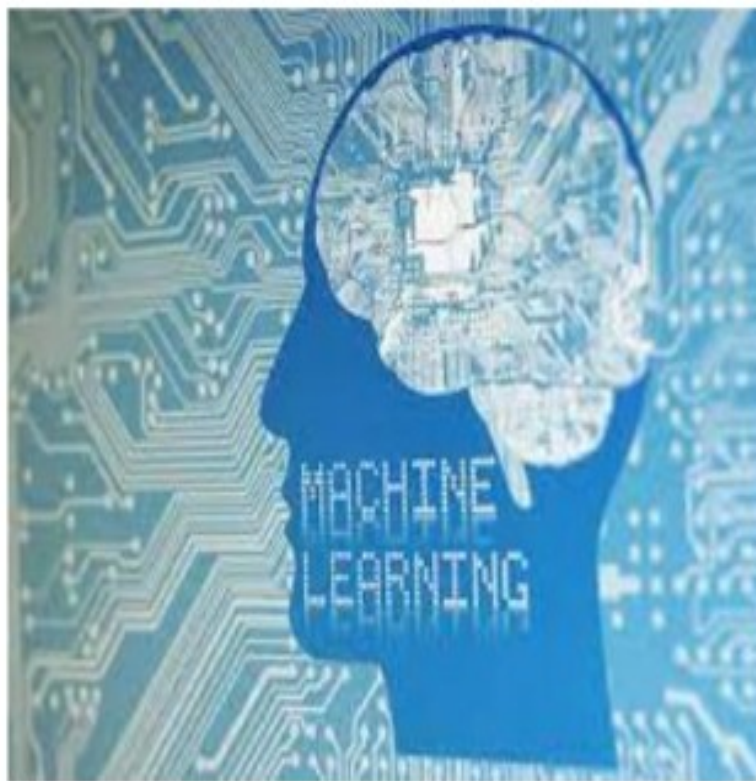


AI vs ML vs DL



- **AI** : broader concept (science+Engineering) to create intelligent machines that can simulate human thinking capability.
- **ML** : subset of AI that allows machines to learn from data without being programmed explicitly.
- **DL**: subset of ML, that uses the neural networks to analyze different factors with a structure that is similar to the human neural system.

What is Machine Learning



- It means that *ML is able to perform a specified task without being directly told how to do it.*
- *Example:*
 - Distinguish between **spam** and **valid email** messages.
Given a set of manually labeled good and bad email examples, an algorithm can automatically learn a set of rules that distinguish them.
 - Language Identification (Amharic, Ge'ez, Tigrigna, Afar, etc) (*How?*)
- Arthur Samuel (1959) defined machine learning as “*a sub-field of computer science* that gives **computers** the ability to learn *without being explicitly programmed.*”

ML Definitions

- Machine Learning (ML) is a subfield of **artificial intelligence (AI)** that focuses on the **development of algorithms and statistical models** that enable computers to perform **tasks without explicit programming**.
- The fundamental idea behind machine learning is to allow machines to **learn patterns and make predictions** or decisions based on data
- ML use techniques to allow computers to **progressively improve their performance** on a specific task as they are exposed to more data over time



ML widely Accepted Definition

Tom Mitchell, a computer scientist and professor at Carnegie Mellon University, widely accepted definition is as follows:

" A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P , if its performance at tasks in T , as measured by P , improves with experience E . "

Breaking it down:

Experience (E): This refers to the data or examples the system is exposed to

Tasks (T): These are the specific activities or problems that the machine is learning to perform or solve.

Performance Measure (P): This is the metric used to evaluate how well the machine is doing in performing tasks from T . accuracy, error rate, or another relevant metrics.

ML definition example cont..

Example:

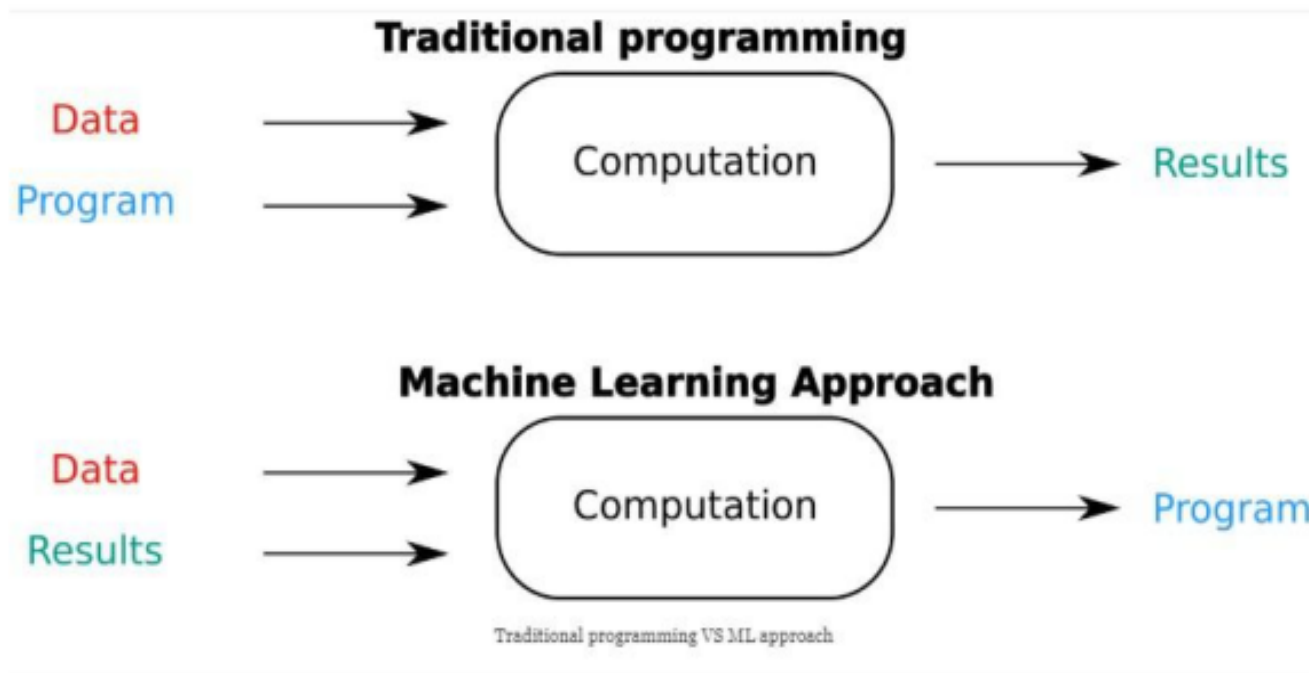
email spam filtering problem

- (task T): identifying spam messages
- (experience E) : using the data of previously labeled email messages
- (performance measure P) : through a machine learning algorithm with the goal of improving the future

Handwriting recognition learning problem

- Task T: Recognising and classifying handwritten words within images
- Training experience E: A dataset of handwritten words with given classifications
- Performance P: Percent of words correctly classified

1.Traditional Programming vs ML



The importance of Machine Learning

- Rapid increment in the production of data
- Solving complex problems, which are difficult for a human
- Decision making in various sector including finance
- Finding hidden patterns and extracting useful information from data.

Classification of ML

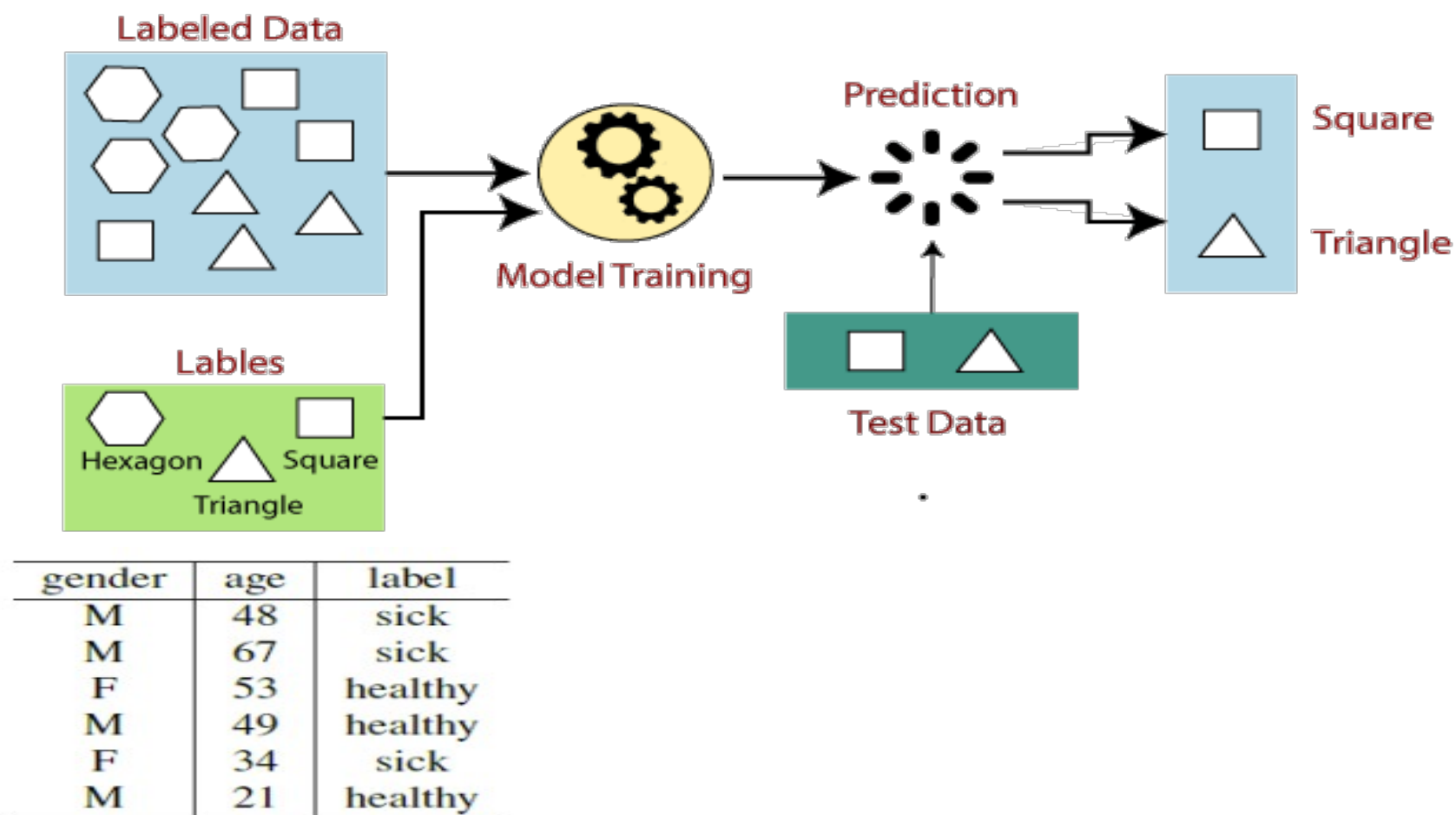
In general, machine learning algorithms can be classified into three types.

- 🕒 Supervised learning
- 🕒 Unsupervised learning
- 🕒 Reinforcement learning

Supervised Learning

- Supervised learning involves training an algorithm on a labeled dataset, where input data is paired with corresponding output labels.
- The goal is to learn a mapping from input to output based on provided labelled examples.
- A “supervised learning” is so called because the process of an algorithm learning from the training dataset can be thought of as a teacher supervising the learning process

Supervised Learning



Supervised Learning

Types of Problem To Solve

✓Classification:

Predicting whether an email is spam or not based on features like **subject**, **sender**, and **content**.

✓Regression:

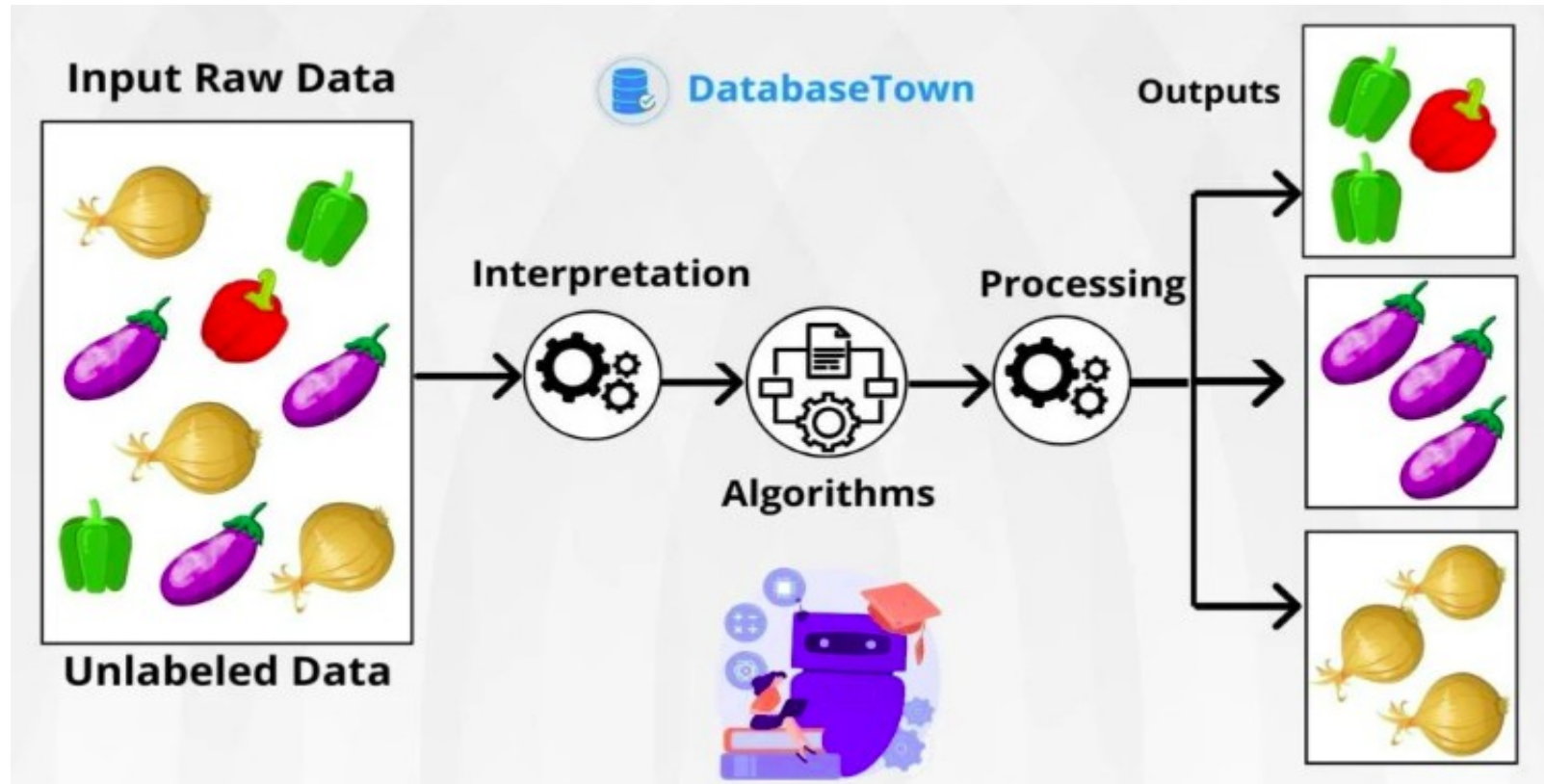
Predicting the price of a house based on features like square footage, location, and the number of bedrooms.

Health care, financial, sentiment....

Unsupervised Learning

- Unsupervised learning involves training a model on not labeled, classified, or categorized, and the algorithm needs to act on that data **without any supervision**,
- The algorithm aims to explore the inherent structure in the data.
- models itself find the hidden patterns and insights from the given data.
- It can be compared to learning which takes place in the human brain while learning new things

Unsupervised Learning



Unsupervised ML Problem Types

A. Clustering:

Grouping similar customers based on purchasing behaviour without predefined categories.

B. Association :

find associations and patterns in the data ex : dimensionality reduction

examples

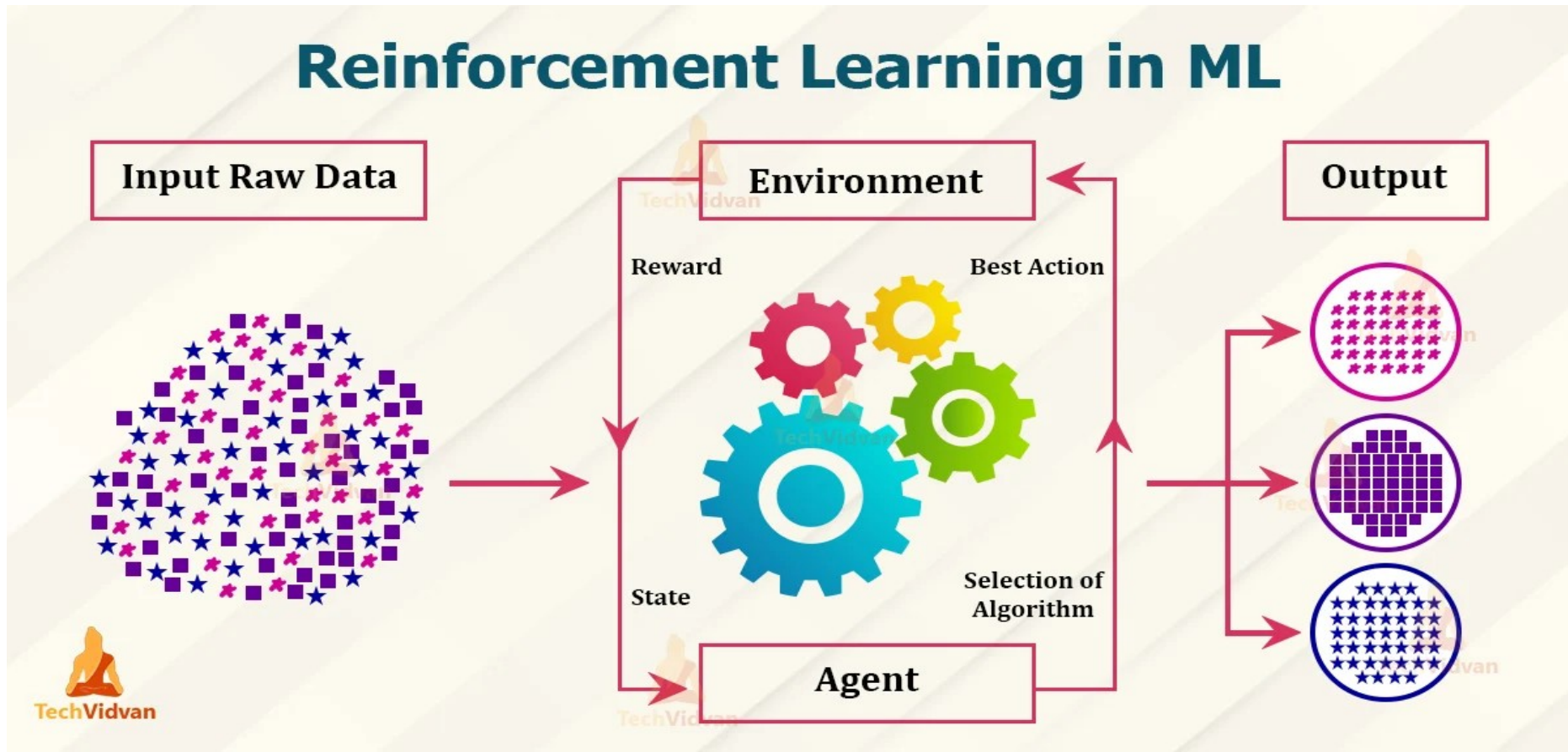
- **Market Segmentation:** Identifying distinct customer segments for targeted marketing campaigns.
- **Anomaly Detection:** Detecting unusual patterns in network traffic for cybersecurity.

Re-Inforcement Learning

- Reinforcement learning involves an agent learning to make decisions by interacting with an environment.
- The agent receives feedback in the form of rewards or penalties based on the actions it takes.
- Reinforcement learning is applicable when an agent needs to learn a sequence of actions to achieve a goal in a dynamic environment, receiving feedback to guide its learning process.

Re-Inforcement Learning

Reinforcement Learning in ML



Re-Inforcement Learning

Controlling A Walking Robot

Agent:

The program controlling a walking robot.

Environment:

The real world.

Action:

One out of four moves (1) forward; (2) backward; (3) left; and (4) right.

Reward:

Positive when it approaches the target destination; negative when it wastes time, goes in the wrong direction or falls down.

Challenges In Machine Learning

- Machine learning projects **encounter challenges** such as
- **data quality** issues,
- **insufficient** data
- the need for **robust model evaluation**.

Limitations of current machine learning approaches:

While powerful, current ML approaches have limitations, including **interpretability issues, susceptibility to bias, and challenges in handling complex, unstructured data.**

Understanding these limitations is crucial for **responsible and effective deployment**.